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ABSORPTION OF LIGHT AND QUENCHING OF LUMINESCENCE

The Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, has produced new studies on luminescence.

Academician S. I. Vavilov and his school have greatly extended the science of luminescence. Vavilov's prolonged and particularly important studies on the fluorescence of molecules in solution clarify the whole science of luminescence and the phenomena connected with the transfer of excitation energy from one molecule to another. Energy transfer, as usually considered in optics, from one molecule to another during the collision of molecules and absorption of energy from a distant molecule by a molecule does not explain all possible phenomena which follow from the classical ideas on light emission and absorption. The inductive interaction of molecules at distances comparable to or less than the wave length of light must lead to resonance energy transfer, even if there are no collisions, by analogy with energy exchange in two coupled oscillatory systems.

Vavilov and his collaborators have shown recently that such resonance transfer of excitation energy plays an important part in the fluorescence of solutions. Vavilov's theory explains, without resorting to special hypotheses, depolarization and quenching of luminescence which are observed for increased concentrations of solution, and forecasts new effects, later confirmed experimentally at the Physics Institute imeni P.N. Lebedev and at the State Optics Institute.

The work of Academician S. I. Vavilov and M. D. Galanin, completed recently in the Physics Institute, is a further development of this problem. The authors studied these consequences which should follow from the concept of inductive bond or coupling between molecules when light irradiates the absorbing medium. Ordinarily, the propagation of light is usually discussed for the case of a remote source. However, specific characteristics arise if absorption takes place at distances of the order of the wave length of the light from the source, the radiating molecule. In the first place, the coefficients of absorption at very small distances from the radiator cannot be constant, due to the more complex structure of the electromagnetic field close

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to the radiating molecule In the second place, the duration of luminescence and of the quenching of fluorescence corresponding to it should observably decrease, since the absorbing molecules, because of inductive coupling, cause more rapid transfer of the energy of the radiating molecule. Both these conclusions were confirmed experimentally.

With the help of a Kubetskiy photomultiplier, the reabsorption of fluorescence radiated by a very thin (less than the wave length of light) layer of the fluorescing and simultaneously absorbing solution was measured. A considerable increase in the coefficient of absorption was observed when the layer was thinner than half wave length. The quenching of fluorescence by absorbing substances was also investigated. The properties of this quenching (parallel decrease in time of liminescence, independence of temperature and viscosity of the solution, dependence upon the relative position of the spectra of fluorescence, and absorption) also corresponded with those expected from theory.

The inductive interaction of molecules as a completely difinite physical mechanism explains energy transfer and also the important phenomena of luminescence and may clarify migration of excitation energy in chemistry and biology, for example.

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